NRC·CNRC
Institute for Research in Construction

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construction innovation

Upgraded test house enables cohesive indoor environment and building envelope research

Over the last few years, in collaboration with its industry and government partners, NRC-IRC has developed a series of world class experimental facilities in support of the housing industry, starting with the twin houses at the Canadian Centre for Housing Technology (CCHT) in 1998, followed by the Flanking Transmission Test Facility in 2005, and most recently, the upgraded Ventilation and Wall Research House.

This new addition to NRC-IRC's full-scale facilities complements the others in many ways. It has borrowed and refined some of their best experimental features, while offering the opportunity for wholesale redesign and adaptation of the interior and the envelope of the house for purposes of investigating technologies that can potentially redefine the house's performance altogether. This facility has the potential to investigate and improve the indoor air quality, comfort, durability and energy efficiency of housing.

Using the new facility, NRC-IRC's *Indoor Environment* and *Building Envelope and Structure* programs are jointly initiating research projects that integrate indoor climate and building envelope performance, and that will holistically assess heat, air and moisture transfers between the outside, the enclosure, the indoor air and the HVAC systems.

To complement the capabilities of the CCHT Research Houses, this facility has been designed to be very flexible and can be reconfigured to allow new series of experiments. Changes to the facility include a fully deployed radiant floor heating system and also zone-controlled

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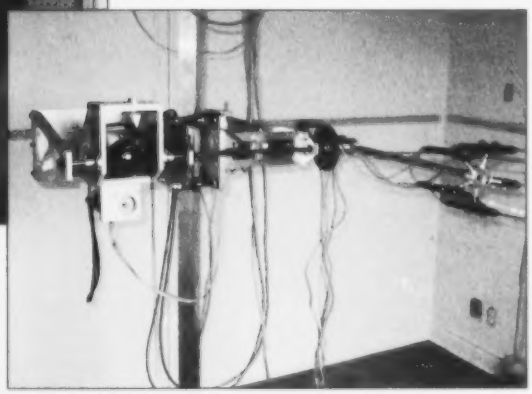
Featured in this issue

Ventilation and Wall Research House

Hybrid heating
Hybrid ventilation
Wall assembly performance



NRC-IRC researcher, James Reardon, installs sensors (above) on the robot arm (right).

The robot's vertical carriage is equipped with an arm bearing the sensors and an infrared camera. The sensors measure temperature and humidity.

Read *Construction Innovation* on the Web at **http://irc.nrc-cnrc.gc.ca/ci**

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Canada

2007-03625/

Changes in Canadian Codes Centre staff responsibilities

The Canadian Codes Centre has recently made changes to the responsibilities of its staff. Staff members are now responsible for specific subject areas instead of each working independently for a specific codes committee. With this reorganization, staff are able to contribute their expertise to the work of several different committees rather than working in isolation.

The technical advisors and their area(s) of expertise and responsibility can be found at http://irc.nrc-cnrc.gc.ca/codes/staff_e.html.

Codes Centre staff provide opinions only on the content of the codes. These opinions are not official interpretations of the legislated requirements contained in the national construction codes, as this is the responsibility of the provinces and territories.

If you need an official interpretation of building, plumbing or fire regulations, you must contact the "authority having jurisdiction" (municipal or provincial/territorial building officials) in your province or territory.

You can contact Codes Centre staff for opinions on the content of the national construction codes at 613-993-9960, fax 613-952-4040, or e-mail codes@nrc-cnrc.gc.ca.

www.nationalcodes.ca

New CCMC Evaluation Reports

Company	Product Name	CCMC #	Description
Cosella-Dörken Products Inc.	Delta Drain (Standard)	13209-R	The "Delta Drain (Standard)" is a geocomposite drainage system composed of a high-density polyethylene, quasi-rigid plastic sheet core membrane, with a dimpled surface on one side and a smooth surface on the other, and a polypropylene heat-bonded geotextile filter fabric attached to the raised dimples. It is intended for use in areas of high rainfall or flood zones where there is high surface water drainage.
Barrier Sciences Group	Insul-Barrier LD	13249-R	"Insul-Barrier LD" is a spray-in-place, low-density, semi-flexible polyurethane foam insulation with an open cell structure. This product can be used in new or retrofitted construction.
DuPont™ Canada Incorporated	Tyvek® CommercialWrap® –Air Barrier Material™	13253-R	"Tyvek® CommercialWrap®–Air Barrier Material™" comes in sheet form and is made of high-density polyolefin. The product has demonstrated sufficiently low air permeance such that it can be considered as the principal plane of airtightness in an air barrier system.

For further information on the performance, usage and limitations of these products, as well as other reports and listings by CCMC, see the Web Registry of Product Evaluations located at **http://irc.nrc-cnrc.gc.ca/ccmc/regprodeval_e.html**.

2006 edition of Registry of Product Evaluations now available in both CD-ROM and book formats!

CCMC is pleased to announce the release of the 2006 edition of the Registry of Product Evaluations. The Registry of Product Evaluations contains evaluation reports and listings for over 500 products evaluated by CCMC. The documents can easily be found according to MasterFormat number, manufacturer's name, product name, or report or listing number.

The Registry of Product Evaluations is available free of charge on CD-ROM. It is also offered in a soft cover book format for $5.00 (plus shipping and handling fees). The official version of CCMC's Registry of Product Evaluations, which is updated quarterly, can also be viewed free of charge on the Web at **http://irc.nrc-cnrc.gc.ca/ccmc**.

To order the 2006 edition of the Registry of Product Evaluations, please visit the NRC's Virtual Store at **www.nrc.gc.ca/virtualstore** or contact NRC-IRC's Publication Sales Department at 1-800-672-7990.

Upgraded test house enables cohesive indoor environment and building envelope research

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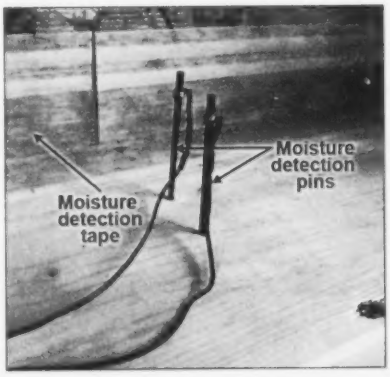
forced-air heating and cooling systems. These systems can be run one at a time, or in combination (hybrid), to investigate whether some types of rooms are better served by one type of heating and ventilating system as opposed to another.

Given the emphasis on zone control, some walls were taken down and new rooms added, resulting in a totally redefined interior layout, which allows for a more in-depth investigation of the impacts of the different systems. In addition, an entire section of an exterior wall was replaced with a test-bay that can accommodate three different wall systems side-by-side, with each system fully instrumented and monitored.

The recent upgrades enable research on topics that highlight the interrelated nature of the indoor environment and envelope performance, allowing researchers to investigate the influence of choice, of the heating and cooling system or the air circulation approach, on both comfort conditions in the rooms and the hygrothermal performance of the building envelope.



Traditional moisture sensors (pins) and a new innovative type of sensor (tape) measure moisture content in a wood-stud wall with OSB sheathing.

If, for example, a heating system results in uneven distribution of heating in the rooms of the house, researchers will be able to quantify in a single experiment the impacts on occupant comfort and wall moisture performance. As another example: in the case of living situations where there are high indoor humidity conditions, and hence where envelope surface condensation and mould are likely to occur, one heating system may be shown to deliver more comfortable living conditions while also promoting more resistance to the formation of condensation and ensuing mould growth. Both examples point to the capabilities of this facility, which are expected to be of special interest to component manufacturers and builders who want to present a complete performance package to their clients. (See sidebar below)

Research is now underway in the research house in the following three areas:

- Hybrid heating, which incorporates a combination of zone-controlled radiant floor heating and zone-controlled forced-air heating to achieve optimal air circulation for a particular room depending on its use.
- Hybrid ventilation, which incorporates combinations of mechanical air exchange and ventilation openings in the walls and chimneys.
- Hygrothermal performance of exterior wall assemblies that have different wall assembly techniques, insulation systems and air- and vapour-barrier approaches.

The upgraded Ventilation and Wall Research House offers new capability to study the interrelationships between building envelopes and indoor environments and NRC-IRC is seeking partners for its investigations. For more about the current projects, see page 4 and page 5.

Ventilation and Wall Research House
Modifications and capabilities

Changes to the research house	*Allows for the investigation of:*
Building envelope	moisture management strategies for high humidity conditions
Mechanical systems	zone-by-zone control capability for the forced-air heating and cooling
Hydronic radiant floor heating system added	optimum combinations of hydronic and forced-air heating systems
Room layout	side-by-side testing of the two modes of heating in one house
Humidity control provisions	the effects of normal and high humidity levels on the indoor environment and the building envelope
Measurement systems (sensors measuring temperature, relative humidity, air velocity, etc.)	all variables, providing greater research flexibility and improved precision
Wall testing facility	the hygrothermal performance of innovative wall and window systems relative to variable indoor conditions over a yearly cycle of outdoor weathering.

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Ventilation and Wall Research House

Hybrid heating

The majority of new houses built in Canada are equipped with combustion-fired, forced-air heating systems. Although there have been many improvements to forced-air systems in the past three decades, this may not be the most energy-efficient way to deliver thermal comfort to occupants. NRC-IRC is using the upgraded Ventilation and Wall Research House to see if further improvements can be gained by combining the best features of hydronic radiant floor heating and forced-air heating. This research is being conducted in parallel with a project investigating residential hybrid ventilation systems, taking both indoor air circulation and quality into consideration.

Hydronic radiant floor heating provides the comfort of a warm floor, and in many ways, is a more energy-efficient means of delivering thermal comfort due to the much greater heat capacity of water in comparison to air. Also, radiant heating may allow a reduction in indoor air temperature without compromising comfort, thereby reducing heat losses by conduction through walls and windows. However, radiant floor heating, on its own, does not provide adequate air distribution, so supplementary ventilation schemes are needed.

Hybrid heating systems combining radiant floor and forced-air heating may provide improved thermal comfort and greater energy efficiency for

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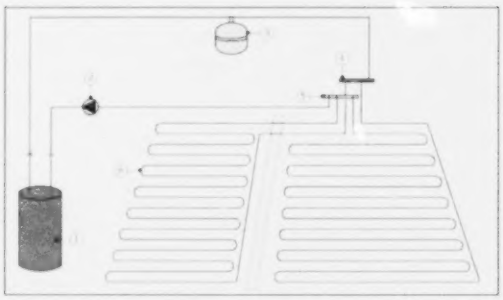
Boiler system for Ventilation and Wall Research House



Radiant floor heating system
1. Water heater
2. Circulator
3. Expansion tank
4. Supply manifold
5. Return manifold
6. Radiant panel – PEX tubing loops

Hybrid ventilation

In parallel with the hybrid heating research, NRC-IRC is using the upgraded test facility to study combinations of natural and mechanical ventilation. This project provides the opportunity to ensure that innovative hybrid ventilation strategies will be suitable for houses, with or without good indoor air distribution provided by the (forced-air) heating system. This is an important piece of work because ventilation and air-conditioning can account for up to 50% of residential energy consumption and have a direct impact on occupants' health and comfort.

Natural ventilation may result in too little or too much fresh air exchange, and may waste energy in heating or cooling a space. Mechanical ventilation is easily controlled and enables heat recovery and filtration but it consumes electrical energy and thereby promotes greenhouse gas emissions. Hybrid ventilation, combining the advantages of both natural and mechanical ventilation, may offer a way to reduce the energy used for building ventilation.

This project will evaluate innovative hybrid ventilation strategies for single-family residential buildings in terms of meeting code (NBC) requirements and indoor air quality standards, as well as achieving occupant satisfaction and energy efficiency. The research will first determine the natural ventilation rates typical in existing Canadian houses.

The experiments will assess several hybrid strategies in terms of ventilation rates and distribution, energy consumption and thermal comfort for a full range of weather conditions. The experimental process will employ and evaluate intelligent control systems that automatically switch between natural and mechanical ventilation modes and modulate fan speeds and/or

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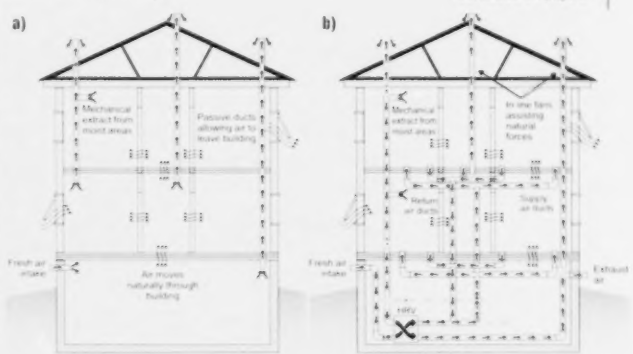


a) Natural ventilation system **b) Hybrid ventilation system**

Hygrothermal performance of wall assemblies

The wall testing capability of the upgraded research house will be used to assess innovative wall assemblies and windows relative to variable indoor conditions over multiple seasons.

The new test facility complements NRC-IRC laboratory and numerical modelling capabilities in the area of heat and moisture transfer across the building envelope so that test results can be compared to theoretical results generated by modelling tools developed at NRC-IRC (*hyg*IRC 1-D and 2-D).

Experiments with three identical test specimens of traditional 2 x 6 wood-frame wall construction will run until spring 2007 to test and validate the facility and the data acquisition system.

NRC-IRC is seeking partnerships with public and private agencies to investigate issues of heat and moisture flows across wall assemblies.

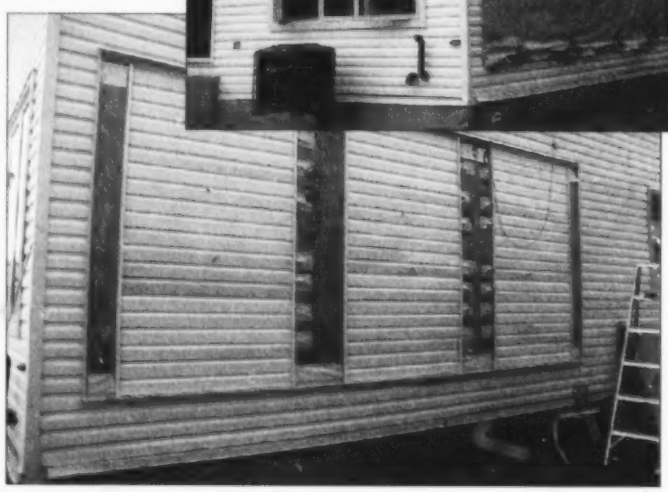
During the winter months of 2006–7, the test specimens will be subjected to increased indoor relative humidity and air exfiltration to examine the condensation potential in different layers of the assemblies and to yield valuable information on the systems' strengths and weaknesses. With the coming of spring, researchers will monitor the drying potential of the test specimens. In May 2007, the research team will dismantle the specimens and examine the materials for signs of deterioration, and the next series of specimens will be installed.

NRC-IRC is seeking partnerships with public and private agencies to investigate issues of heat and moisture flows across wall assemblies. Researchers expect to advance building envelope science and performance assessment in the following areas:

- Innovative coatings and membranes that perform multiple hygrothermal functions at different times of the year (e.g. smart vapour barriers).
- Vapour barrier, air barrier and heat flow control strategies to achieve minimal wetting and maximal drying of wall assemblies over cycles of seasonal loading.
- Traditional or innovative insulation systems designed to provide thermal resistance and other functions (e.g., insulations that also act as vapour and/or air barriers).
- Innovative wall or wall/window configurations designed for temperature and humidity control.
- Field benchmarking of the NRC-IRC envelope environmental exposure facility (EEEF), a complementary laboratory facility designed to mimic outdoor and indoor climate loading, and of *hyg*IRC numerical modelling software for building envelope optimization.

For more information about the test facility and partnership opportunities, visit the Web site at http://irc.nrc-cnrc.gc.ca/bes/hmpe/fieldfewf/index_e.html, or contact Dr. Wahid Maref at 613-993-5709, fax 613-998-6802, or e-mail wahid.maref@nrc-cnrc.gc.ca.

West façade of research house includes a test bay that allows wall specimens to be exposed to controlled indoor conditions and natural outdoor weather conditions.



Three wall specimens being instrumented in preparation for field monitoring Fall 2006 and Spring 2007.

Reinforced concrete structural members strengthened by insulated FRPs perform well in fires

In North America, the restoration and maintenance of deteriorating infrastructure, mainly as a result of corrosion and heavy use, has become a major component of the construction market. In recent years, fibre-reinforced polymers (FRPs) have emerged as a promising material for prolonging the life of structures (such as bridges and parking garages) and reducing maintenance costs.

While FRP products have been shown to enhance the capacity of these structures, their application in interior spaces, where fire is a significant concern, has been questionable because of the lack of information regarding their behaviour at elevated temperatures.

In collaboration with researchers at Queen's University (members of ISIS Canada) and industry partners Fyfe Co. and BASF Building Systems, NRC-IRC researchers have studied the fire performance of reinforced concrete structures that have been wrapped with FRPs to strengthen them, and then insulated to provide fire protection (see Figure 1).

The research involved both experimental and numerical studies of the fire performance of reinforced concrete columns, beams and slabs that had been strengthened with FRPs and protected with two different types of fire insulation material. A total of nine full-scale tests (five columns and four beam/slab assemblies) and four intermediate-scale tests (slabs) were conducted under standard fire exposure (see Figure 2).

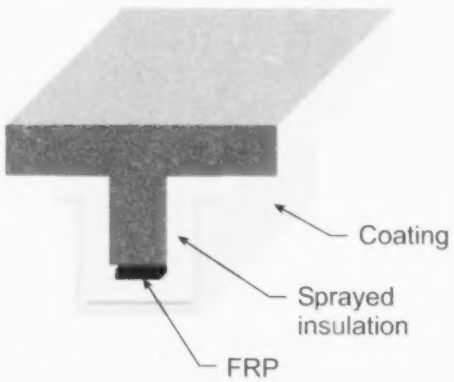
Numerical modelling

Researchers developed numerical models to predict the fire resistance of the different types of members that were tested. The numerical models were then validated against the experimental data obtained from the fire testing (see Figure 3). These models are capable of predicting, with sufficient accuracy, the thermal effects of fire on the reinforced concrete column, beam or slab, epoxy, FRP and insulation, as well as on the load capacity of FRP-strengthened concrete columns and beam/slab assemblies.

Key experimental findings

The study demonstrated that:

- FRP-strengthened systems that were adequately insulated achieved a minimum four-hour fire resistance rating under service load.
- The insulating fire-protection systems maintained low temperatures in the concrete and reinforcing steel, thus enabling the concrete and steel to retain most of their ambient strength during the fire tests.
- Even though the glass transition temperature of the FRPs was exceeded, satisfactory fire resistance ratings were achieved because the insulation stayed in place. The insulation and its proper installation were key to protecting the structure.



a) Beam/slab system

b) FRP bonding

Figure 1. Reinforced concrete structures wrapped with FRPs

The glass transition temperature (GTT) is the temperature at which FRPs experience degradation in strength, stiffness, and bond.

Based on the results of this research, design guidelines are being developed.

Specific questions about this project can be directed to Dr. Noureddine Bénichou at 613-993-7229, fax 613-954-0483, or e-mail noureddine.benichou@nrc-cnrc.gc.ca.

Phase 2

NRC-IRC, Queen's University (ISIS Canada) and industry have initiated Phase 2 of the study on the fire resistance of FRP systems, which will investigate rectangular concrete columns repaired with FRP sheets, and beams and slabs repaired with near-surface-mounted (NSM) FRP reinforcement. This phase will include the following:

- material characterization
- experimental studies of fire behaviour
- development of validated numerical models
- parametric studies using the numerical models
- development of design guidelines

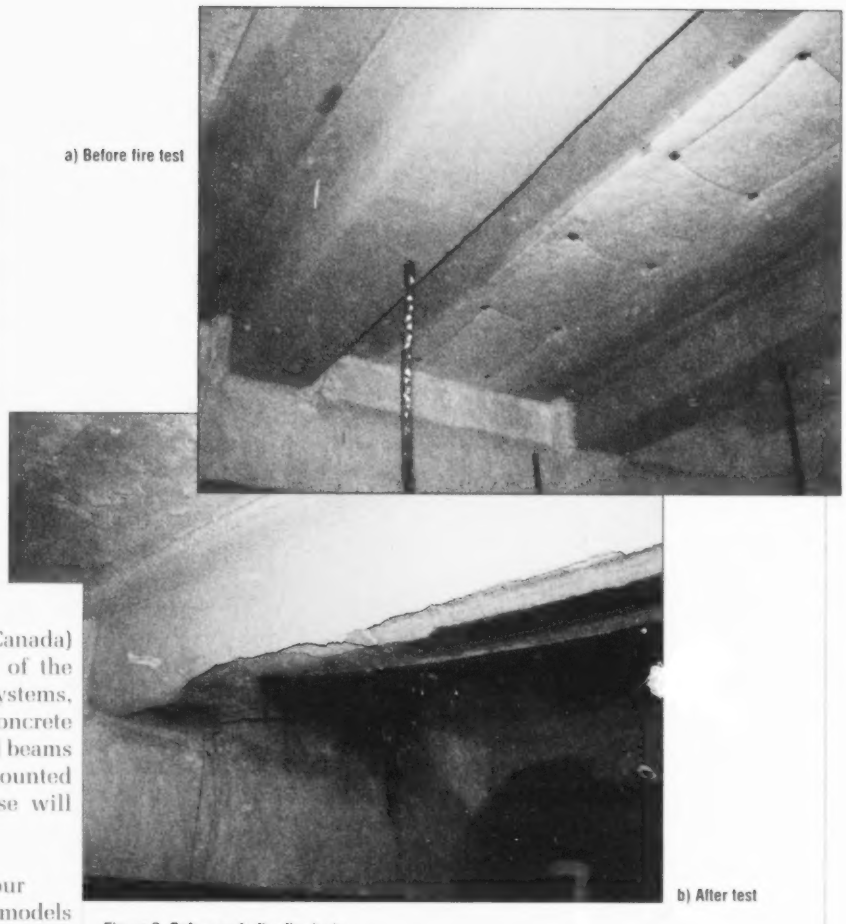


Figure 2. Before and after fire tests

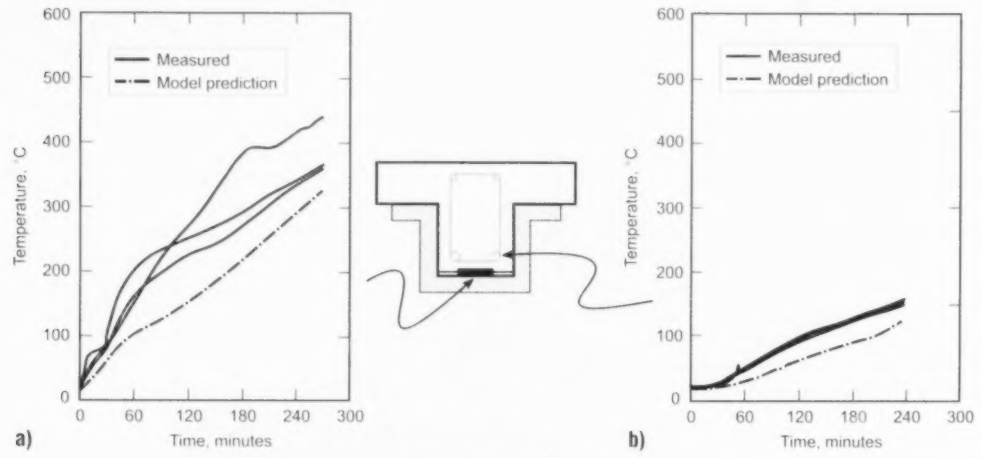


Figure 3.
Predicted vs measured temperatures
a) Temperatures at FRP/concrete interface
b) Temperatures of steel rebar

NRC Centre for Sustainable Infrastructure Research initiatives make progress

The future is here at the NRC Centre for Sustainable Infrastructure Research (CSIR) in Regina, Saskatchewan. Two years ago, *Construction Innovation* described the flurry of activity afoot as CSIR prepared to open for business. Today, CSIR is fully staffed and settled into office and laboratory space, including a new off-site Regina Infrastructure Laboratory (RIL), which is being equipped with a pilot-scale water quality testing facility and other test apparatus. Most importantly, initiatives are underway in each of CSIR's areas of interest.

This progress is important. Each year, municipalities spend $12 to 15 billion on infrastructure, 80 per cent of which goes to system repairs and renewals. CSIR is developing new technologies to meet existing and future infrastructure needs and testing them in Regina, which serves as a "living laboratory." If the technologies work in Regina, they can move into the marketplace and widespread use in other municipalities.

To ensure local, national and international relevance, the Communities of Tomorrow (CT) partnership guides the development of the sustainable infrastructure research cluster in Regina, including CSIR. CT brings together NRC, the City of Regina, the University of Regina, Saskatchewan Industry and Resources, Western Economic Diversification, and industry. In cooperation with CT partners, CSIR now has three main areas of research: infrastructure evaluation technologies, decision-support systems and water quality.

Over the past two years, CSIR researchers have made important progress in each of these areas. For example, they are tracking down the cause of a recent increase in breakages of asbestos cement water distribution pipes in Regina. The researchers have instrumented several test pipes and the soil around them, and are now monitoring several parameters, analyzing the results and developing soil-structure interaction models that account for important factors such as soil moisture.

CSIR researchers are also developing tools for integrating and optimizing asset management decisions for water, wastewater and road systems. These kinds of tools would move asset management from isolated pockets of information to a more streamlined system of tools to support decisions about infrastructure. If they are successful, similar systems could be implemented in other communities across Canada.

In addition, CSIR water quality researchers are using the new facility and analytical equipment to investigate remote online monitoring of water quality in water distribution systems, water quality deterioration in distribution systems and the effect of water quality changes on pipe materials. Technology involving online sensors and data analysis would assist small- and medium-sized communities in monitoring water quality situations so they can be addressed before they become serious.

"Working at CSIR has been a rewarding research experience for all involved," says David Hubble, CSIR Manager. "We're engaged with staff at the City of Regina, and increasingly with industry, faculty and students to advance the understanding of sustainable infrastructure construction and renewal through innovative research, technology development and field demonstrations. We've made great progress, and it's just the start."

For more information on CSIR or its projects, visit the CSIR Web site at http://irc.nrc-cnrc.gc.ca/csir/ or contact David Hubble, CSIR Manager, at 306-780-3332, fax 306-780-3421, or e-mail david.hubble@nrc-cnrc.gc.ca.

Results now available from municipal infrastructure investment planning project

Infrastructure managers in Canadian cities and municipalities are being asked to do more with less. Because they're charged with the care of assets essential to daily life and valued in the billions, this task is particularly challenging. Recognizing these difficulties, researchers in NRC-IRC's Urban Infrastructure program set up the three-year collaborative Municipal Infrastructure Investment Planning (MIIP) project (see sidebar for partners) to help them make strategic and cost-effective planning and management decisions.

The first phase of the project resulted in the development of a *Framework for Municipal Infrastructure Management*, which outlines the steps Canadian municipalities must take to manage their assets, emphasizing three main objectives: maximizing performance, minimizing life-cycle costs and minimizing risk. This document can be found at http://irc.nrc-cnrc.gc.ca/ui/bu/miippubs_e.html.

The project also generated a number of important publications that survey the state of asset management in Canada and identify existing tools and techniques for planning, prioritizing and scheduling maintenance and construction. These include the following, which are available free of charge at the same Web site:

- *Survey on Municipal Infrastructure Assets*, which looks at existing levels of infrastructure maintenance in 67 Canadian municipalities (representing approximately 25% of the population of Canada) and reports on the state of Canada's municipal infrastructure assets.
- *Primer on Municipal Infrastructure Asset Management*, which outlines cost-effective asset management practice in Canada and around the world, looks at information technology used for asset management, and works through an asset management strategy for Canadian municipalities.
- *Evaluation of Condition Assessment Protocols for Sewer Management*, which compares several condition assessment protocols to show inconsistencies in sewer condition assessment and stresses the need for an integrated, consistent condition assessment protocol that prioritizes sewer repair and renewal.
- *State of Canadian Sewers—Analysis of Inventory and Condition*, which assesses the condition of Canadian sewers based on data from 14 Canadian municipalities, including an inventory of 9,000 kilometres of sanitary sewer pipes. Condition data for 3,400 kilometres of sanitary pipes were available and used to model pipe performance.

In addition, researchers developed a prototype decision-support software called SSAM-I (Sustained Strategic Asset Management-Integrator), which prioritizes municipal infrastructure maintenance and renewal alternatives using annual cost-benefit optimization. As long as users know the age, value, condition and criticality of an asset, the software can calculate which assets to repair in any given year or number of years based on a specific budget. This prototype software is currently available only to project participants.

NRC-IRC researchers expect to launch Phase 2 of MIIP in March 2007, which will continue the work on the SSAM-I prototype, develop data models for a multitude of municipal infrastructure assets, and collect and analyze service-life data from Canadian municipalities. The particular focus of Phase 2 will be on developing tools and techniques for smaller Canadian municipalities.

For more information on MIIP or to become a partner, contact Dr. Dana Vanier at 613-993-9699, fax 613-954-5984, or e-mail dana.vanier@nrc-cnrc.gc.ca.

A representative sample

The MIIP project brought together partners from 10 major centres across Canada, including the cities of Calgary, Edmonton, Hamilton, Ottawa, Prince George and Regina, the regional municipalities of Durham, Halton and Niagara, and Canada's Department of National Defence. Together these partners represent approximately 25 per cent of Canada's population.

Construction Technology Updates

We welcome your feedback on this publication series. Please visit **http://irc.nrc-cnrc.gc.ca/ctus** and take a few moments to fill out the online form. Your input will help us serve you better.

Thank you.

Hybrid heating

Continued from page 4

the house overall. Both the forced-air and the hydronic radiant floor heating systems in the research house are fully zoned. This allows for an assessment of the efficiency of various combinations of forced-air and radiant floor heating in relation to comfort and energy efficiency. These experiments will take place during the 2006–7 heating and shoulder seasons.

This research is expected to provide a comprehensive evaluation of the comparative energy and comfort benefits of hybrid approaches to home heating and could reduce energy consumption and greenhouse gas emissions. The project's results will also help the industry and consumers make better heating-system choices for both house renovations and new construction.

For more information on hybrid heating research, go to: http://irc.nrc-cnrc.gc.ca/ie/iaq/factsheet12_e.html or contact Dr. James Reardon at 613-993-9700, fax 613-954-3733, or e-mail james.reardon@nrc-cnrc.gc.ca.

Hybrid ventilation

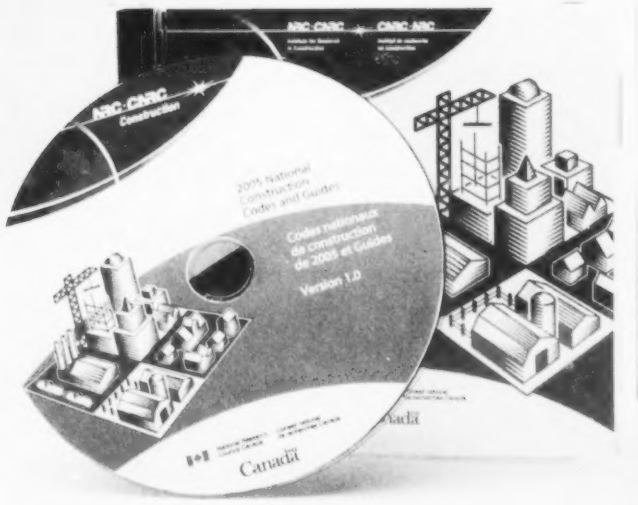
Continued from page 4

vent openings to ensure a steady ventilation rate and adequate interior distribution of the supply air.

This research project has the potential to establish practical hybrid ventilation strategies for houses that reduce energy consumption and peak electric load, and improve ventilation and comfort. NRC-IRC is seeking project partners to obtain input from ventilation and controls manufacturers. The study results are expected to lay the foundation for further development of residential strategies for free cooling, as well as for applications in commercial buildings.

For more information about this project, please contact Dr. Boualem Ouazia at 613-993-9613, fax 613-954-3733, or e-mail boualem.ouazia@nrc-cnrc.gc.ca.

2005 NATIONAL CONSTRUCTION CODES & GUIDES



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The 2005 National Construction Codes and Guides CD-ROM contains the following publications, each of which is controlled by a convenient unlocking mechanism:

- National Building Code of Canada 2005
- National Fire Code of Canada 2005
- National Plumbing Code of Canada 2005
- User's Guide – NBC 2005, Application and Intent Statements
- User's Guide – NFC 2005, Application and Intent Statements
- User's Guide – NPC 2005, Application and Intent Statements

The **CD-ROM version of the 2005 National Building, Fire and Plumbing Codes** includes the Code provisions, which are linked to **application statements** (detailed statements on what the provisions apply to) and **intent statements** (detailed statements on the specific intent of the provisions). The Code provisions are also linked to **objectives** (statements that describe the overall goals that the Code provisions are intended to achieve) and to **functional statements** (statements that describe conditions that help satisfy the objectives).

▲ Sample User's Guide interface

◀ Sample Code interface

Main Features – Codes

- Links allowing easy navigation between various Parts of the Codes
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The User's Guides to the 2005 National Building, Fire and Plumbing Codes contain the **application and intent statements** applicable to the Code provisions. **They do not include the Code provisions: the User's Guides are published as a complement to the printed versions of the Codes.**

Main Features – User's Guides

- Application and intent statements available from drilled-down table of contents
- Instant links to definition of terms, objectives and functional statements
- Powerful, easy-to-use search engine

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- Pentium II processor running at 366 MHz or higher
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- NIC or modem for receiving updates
- At least 500 MB of free disk space
- SGVA monitor (1024 x 768) with 16-bit colour

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Publications*

TITLE	Printed Copy: Binder	Specify Quantity	Printed Copy: Soft Cover	Specify Quantity	CD-ROM Format: STAND ALONE: 1 User	Specify Quantity	CD-ROM Format: NETWORK PACKS (# of Users concurrent): 1-5 Users	Specify Quantity	1-10 Users	Specify Quantity
new **National Building Code 2005**	$200		$190		$350**		$1,400		$2,100	
new **National Fire Code 2005**	$140		$130		$250**		$1,000		$1,500	
new **National Plumbing Code 2005**	$120		$110		$180**		$720		$1,080	
Practical 2005 NBC User's Guides: new Structural Commentaries (Part 4)	n/a***		$94							
new User's Guide – NBC 2005, Application and Intent Statements	n/a		n/a		$150		$600		$900	
Practical 2005 NFC User's Guide: new User's Guide – NFC 2005, Application and Intent Statements	n/a		n/a		$110		$440		$660	
Practical 2005 NPC User's Guide: new User's Guide – NPC 2005, Application and Intent Statements	n/a		n/a		$60		$240		$360	
Quebec Construction Code 2001	$120		$110		$179****		$715		$1,073	
National Farm Building Code 1995	n/a		$34		$51****		$204		$306	
Alberta Building Code 1997 on CD	n/a		n/a		$149****		$596		$894	
Alberta Fire Code 1997 on CD	n/a		n/a		$104****		$416		$624	
Subtotal:										
Discount:										
Subtotal:	1)		2)		3)		4)		4)	

* 1995 editions also available
** Includes application and intent statements
*** n/a = not applicable
**** Network pack of 1-2 users also available

Calculating your order

1) Binder subtotal		
2) Soft cover subtotal	+	
3) Stand-alone CD subtotal	+	
4) Network CD packs subtotal	+	
5) **Total shipping** (Binder & soft cover)	+	
6) **Total shipping** (CD's)	+	
Handling	+	$5.00
Subtotal	=	
6% GST or 6% HST (of Subtotal)	+	
Total (Cdn $)	=	

Courier Collect (if applicable)

COURIER COMPANY

COURIER ACCOUNT #

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About Payment

Prepayment is required on all orders. Please note that all prices are in Canadian dollars and may change without notice. Make out cheques or money orders to **"Receiver General for Canada."** Please allow 4 to 6 weeks for delivery.

Note: All sales are final. No refunds will be issued.

Low Shipping Charges

Add all shipping charges (CD and documents) to the calculation of your order

	ORDER VALUE		CANADA	U.S.	OTHER
5) Binder and Soft Cover Documents	$60 or less	add	$4	$8	$10
	$61 - $199	add	$6	$10	$25
	$200 - $499	add	$10	$20	$50
	$500 - $999	add	4%	10%	12%
	$1000 - $1999	add	3%	8%	10%
	over $2000	add	2%	6%	8%
6) CD-ROM	per disk	add	$6	$8	$10

Courier services available at cost

Discounts: Package Deals

- $60 discount on minimum order of 3 different 2005 National Codes (same printed format)
- 25% discount on Quebec Construction Code with proof of purchase of NBC 1995
- Bulk orders: 10% discount on minimum order of 10 copies of same printed document
- Bookstores: 25% discount on minimum order of 10 printed documents

Note: Discounts may not be combined.

Payment Method

❑ VISA ❑ MasterCard ❑ AMEX

SIGNATURE

ORDER DATE (DD/MM/YY)

PRINT NAME

CARD NUMBER

EXPIRY DATE

or please enclose:

❑ Cheque

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❑ Contractor
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❑ Bookstore
❑ Home Builder/Renovator
❑ Engineer/Consultant
❑ Technologist
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❑ Manufacturer/Supplier

❑ Check here if you do NOT wish to receive future updates and other notices

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Upcoming events

JANUARY

27-31
ASHRAE 2007 Winter Meeting. Dallas, TX.
http://www.ashrae.org/events/

29-31
AHR Expo. International Air-conditioning, Heating, Refrigerating. Dallas, TX.
http://www.ahrexpo.com/

29-31
Fire and Materials 2007. San Francisco, CA.
http://dspace.dial.pipex.com/intercomm/html/events/fm07a.htm

FEBRUARY

14-15
BC Construct. Vancouver.
http://www.bcconstruct.com/

23-25
64th Canadian Home Builders' Association National Conference, Charlevoix, QC.
http://www.chba.ca/conference/

Building Science Insight

Regard sur la science du bâtiment

www.bsi.gc.ca

Seminar series – 2006
Séries de séminaires – 2006

Infrastructures durables : Techniques, outils et guides

(Remaining seminars in French only)

February 20
Montreal – Holiday Inn Montreal-Midtown
420 Sherbrooke St. W.
Montreal, QC H3A 1B4
Tel: 514-842-6111

February 22
Ste-Foy – Hotel Classique
2815 boulevard Laurier
Quebec, QC G1V 4H3
Tel: 1-800-463-1885

We have reserved a block of rooms for your convenience. To reserve your room, please call 418-658-2793 or 800-463-1885 and mention "National Research Council, Folio # 62220."

MARCH

22-23
National Building Envelope Council. 11th Canadian Building Science & Technology Conference. Banff, AB.
http://www.nbec2007conference.com/

28-30
ICBEST: International Conference on Building Envelopes Systems and Technology. University of Bath, Bath, England.
http://www.icbest.org/

APRIL

16-17
International Winter Construction Symposium and Expo. Shaw Conference Centre, Edmonton.

MAY

14-18
CIB World Building Congress 2007: Construction for Development. Cape Town, South Africa. http://www.cibworld.nl/website/newsletter/0606/wbc07.html

JUNE

4-6
Fifth International Conference on Concrete under Severe Conditions Environment and Loading. Tours, France.
http://www.consec07.fr/

10-14
CLIMA 2007 Conference: WellBeing Indoors. Helsinki, Finland. http://www.clima2007.org

This calendar does not include all events scheduled to take place during this time frame. For a more complete listing, see the Web version of "Upcoming events" at http://irc.nrc-cnrc.gc.ca/events_e.html

construction innovation

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Institute for Research in Construction
National Research Council Canada
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Client Services:
Tel.: 613-993-2607 **Fax:** 613-952-7673

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